In Salah Gas

Carbon Dioxide Storage In The In Salah Gas Project Central Algeria

Clive Bishop





Abstract





Carbon Dioxide Storage in the In Salah Gas Project. Algerian Central Sahara

by Fred Riddiford, Abdelaziz Tourqu, Clive Bishop, Brian Taylor, Erik Hulm

The In Salah Gas Project is a BP/Sonatrach Joint Venture that is targeted to produce 9 bcm/y from several gas discoveries located in the Ahnet - Timmimoun Basin, in Central Algeria. These fields, located 500 kilometres from existing gas export infrastructure at Hassi R'Mel, requires a multi billion dollar investment in new pipelines and gas processing infrastructure, with the exported gas destined for the markets of Southern Europe.

Gas production from the In Salah gas fields, contain significant fractions of carbon dioxide ranging from 1%-9%. To meet gas composition specifications for the gas transmission network it is necessary to remove a large proportion of this carbon dioxide in the processing facilities, prior to export. Sonatrach and BP both have goals to reduce greenhouse gas emissions to the atmosphere, so disposal of the carbon dioxide into the atmosphere was not an option. A review of alternative uses for the carbon dioxide was therefore undertaken, leading to selection of sub-surface storage in Tournaisian aged reservoir sandstones adjacent to one of the main gas fields, as the preferred option.

Detailed reservoir simulation modelling was used to aid the design of the carbon dioxide storage scheme, as was 3D seismic, which helped define the reservoir storage potential, reservoir quality and target well locations. Full equation of state simulation was used to capture the sub-surface phase behaviour of the injected carbon dioxide. Model results were used to identify injection well locations that satisfy a number of criteria the most important being to avoid carbon dioxide breakthrough or leakage to the gas producing wells during the life of the field, access to sufficient connected pore-volume to accommodate the predicted volumes of carbon dioxide, which over the life of the project runs to ~ 0.5 Tcf of $CO_2(\sim 25$ million Tonnes) and storage integrity with the free CO_2 migrating back into the hydrocarbon trap over time once production had cessed.

The first of the CO2 injection wells has been drilled with the remaining 2 wells to be completed for first gas, in 1Q04. The impact of this scheme is to reduce emissions from the In Salah Gas project by ~60%.

Talk Outline



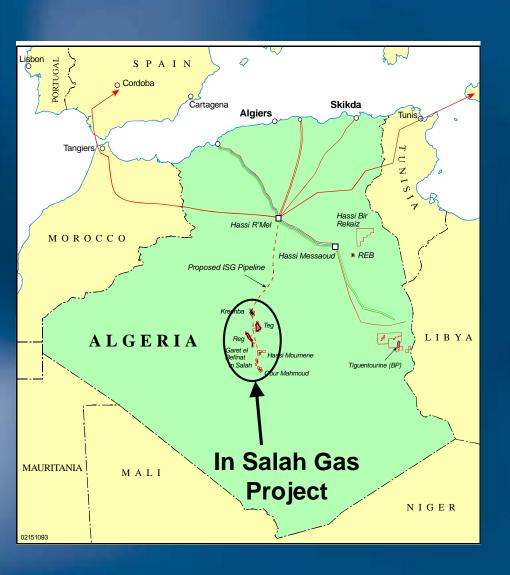


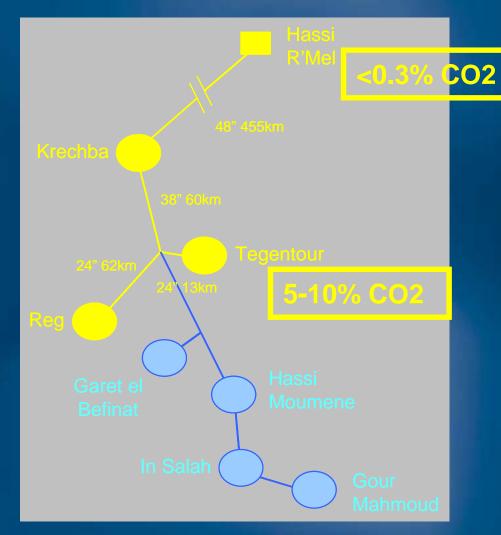
- Outline of In Salah Gas Project Scene Setting
 - Sonatrach/BP Joint Venture
 - Multi-field Gas Development
- Options for Managing CO₂
 - Storage of Associated Produced CO₂
 - Management of Facilities Generated CO₂
- Minimising Risk
 - Assurance of Storage Option
 - Prediction of CO₂ behaviour
- Project Status

In Salah Gas Project Location, Algeria









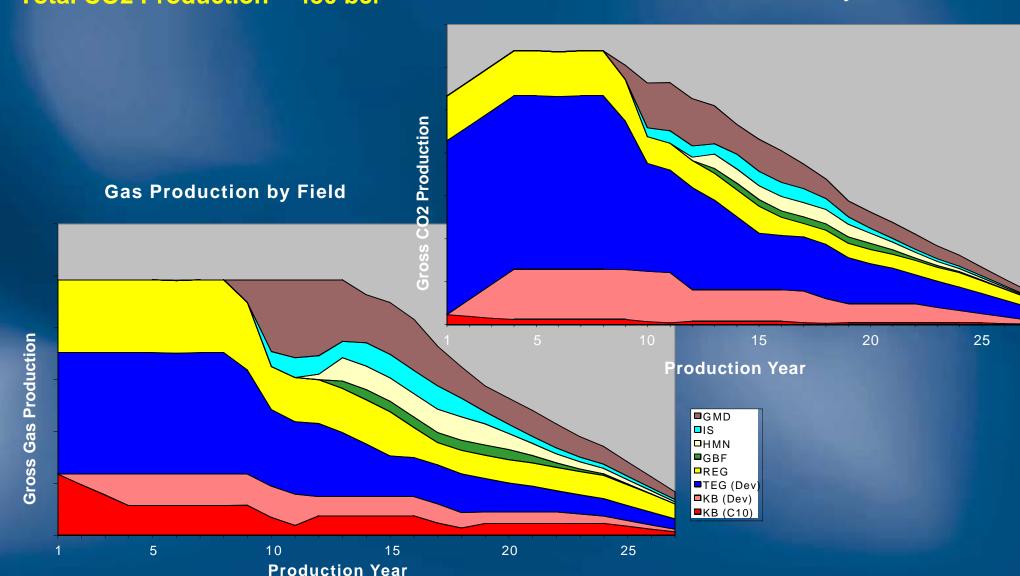
Carbon Dioxide Production Profile





- Maximum CO2 Production Rate ~60 mmscf/d
- Total CO2 Production ~450 bcf

CO2 Production by Field

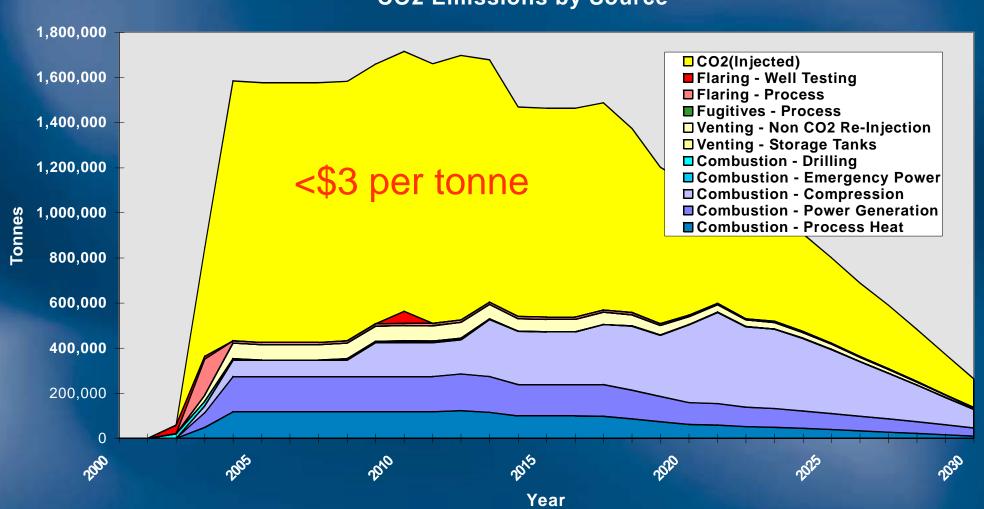


Evaluation of Emissions by Source





CO2 Emissions by Source



Review of Storage Options for Produced CO₂



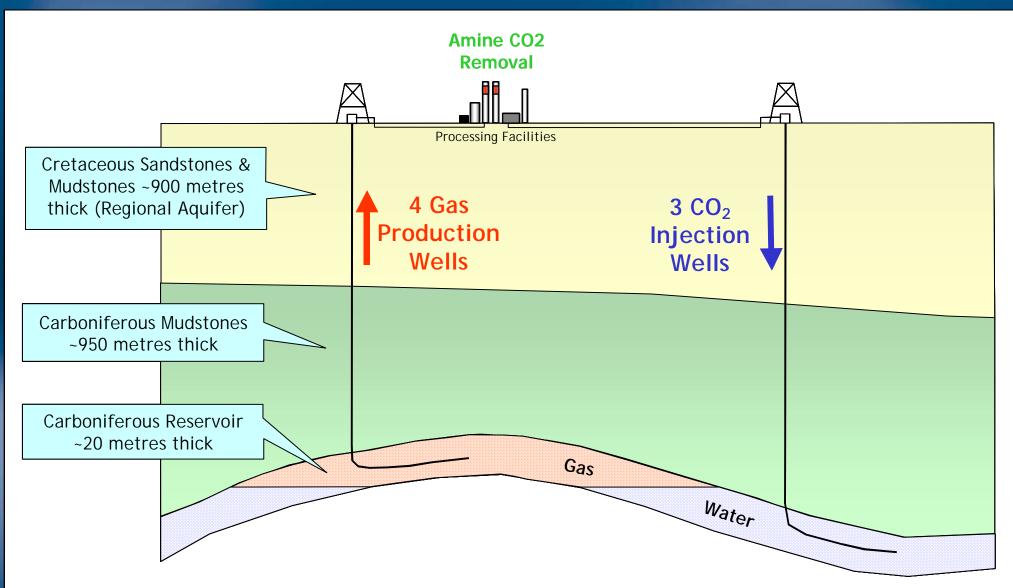


- Robust storage site
 - > Seal integrity
 - > Storage volume
 - > Reservoir quality
 - > Pressure below 6000psi
- Single or multiple sites?
- Carboniferous reservoir at Krechba
 - > Proven hydrocarbon trap
 - > 3D seismic data
 - > Appraisal wells

CO₂ Storage at Krechba



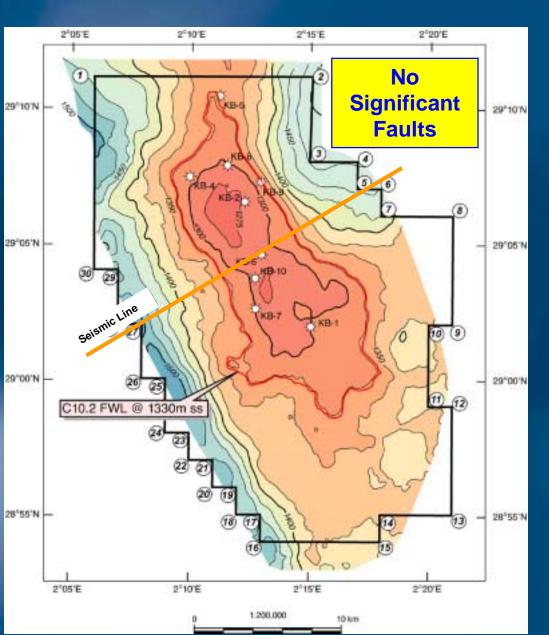


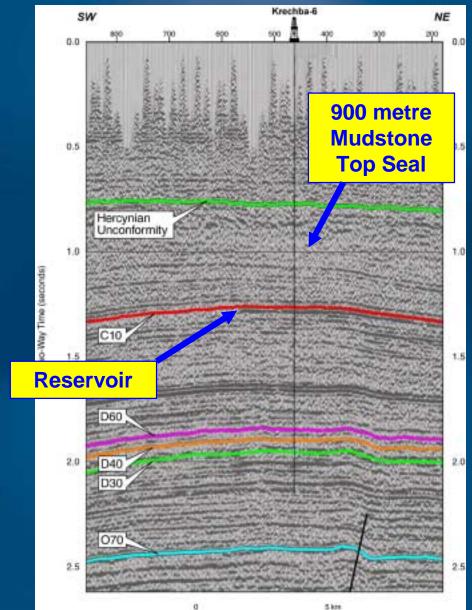


Krechba Geology

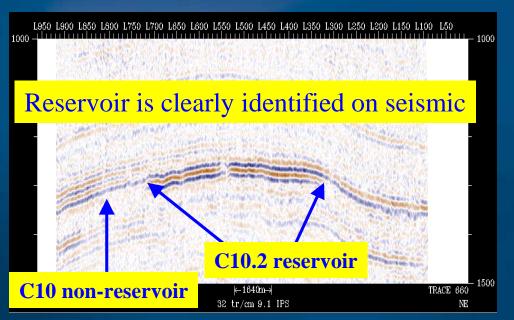


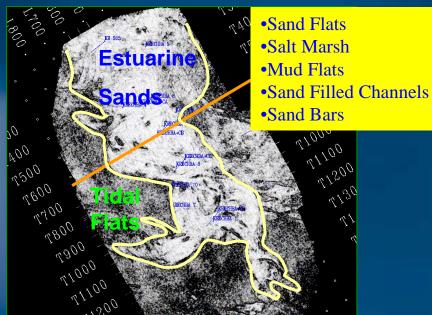






Krechba Geology









Krechba Geological Prognosis

Ground Level Elevation -470 metres above mean sea level

ŧ		Section of the sectio	No.	UPGOSE	PARKTS.	52600	11211	DAY OFF	AND TH Clost	DEFASS	testorrow	HEADANG.
	100000000000000000000000000000000000000	CHETACKOUS	11.0						1 2 2 2	Stort Man	MIDSTONE: gray green, red, grading to elections, occasionally dotorsis: triesbests of DOLDWITE: grey, first, argiflossous	10.56° coming after set becond bear of Conference Engineerung to between terface carbonative
9 0 0 3		NAME.								800	SANDSTONE: quertron, light grey- tect, clustes-very course, processorally colorescus with red / brown sittatine	Devent toxes possible in Continents in Specime and Interceipte which a bounder protein fruit protein growing water in the region.
# E T A G	~	S CONTINENTALINTENCALANE	079		The second secon					CasiPMC Systems 1.85-1 - 3.50	SANDSTONE: quantition, light grey- red, coaste-very coaste, occasionally colorisous with red / brown sitiative	
•											MLDSTONE bown, subtable, accessionally measures, grading to officine. ANY/CRITE wide, but	Listone groupline in upper CSS (Viteral)
0	E A 16										MLDSTONE: dark gray-black subflade, occasionally busiliterus, mass DOLOMITE and pyrite. DOLOMITE: gray first-hast, crystaline	1) 3-9" coming above on or mid QED Allegard to accome Continuous and behavioran and again COS (Allegar).
	N + B	CDE	150						1 DW	130.90	MUDSTONE: san grey block subfissio, occasionally fossilitation, trace DOLDMITE and synta.	
# W 13	TLANSON AND	C10.					200	L	900m	1.47.50	MLDSTONE: grey authoria, grading to altistone, very occasionally fire sandsone, trace DOLDMITE SANDSTONE: guarterize colouriests, fine garriest occasionally occasionate. WLDSTONE: grey subfessie, grading to situation.	
EVORIAN	IITHUMANA	1370						410' perpet by		PACCORNE Sort 1 10 1 15 50		

Forecast CO₂ Storage Capacity and Times (Years)



10.14



10 Outlier

17.57

149.2

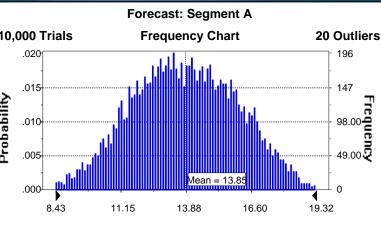
Forecast: Segment C

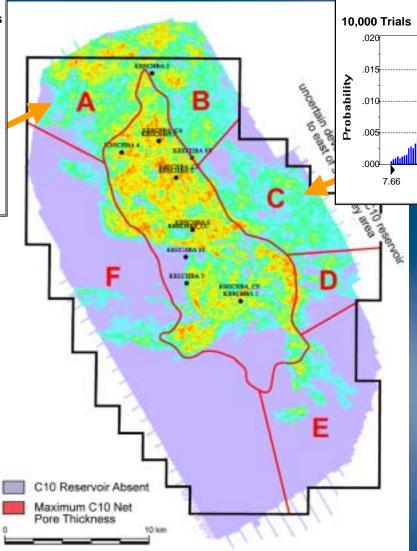
Mean = 12.6

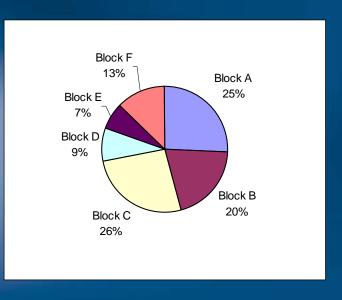
15.10

12.62

Frequency Chart



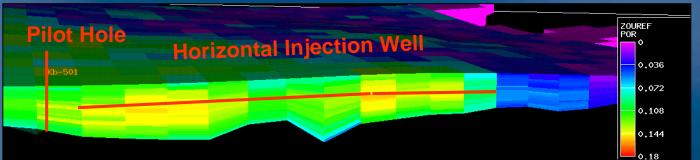


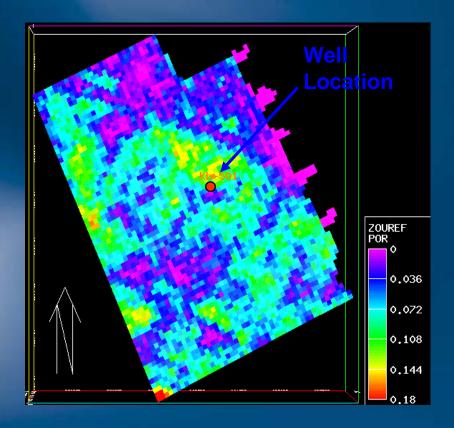


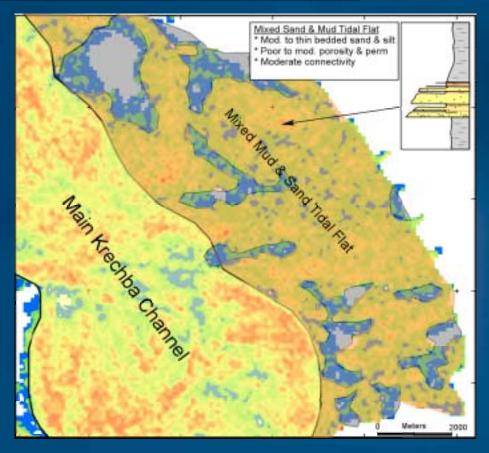
Simulation Models







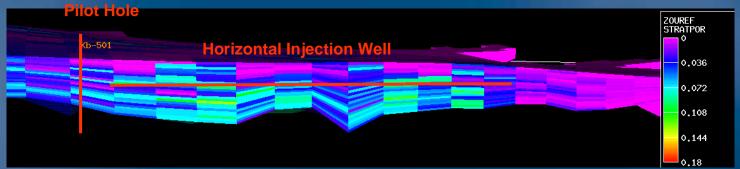


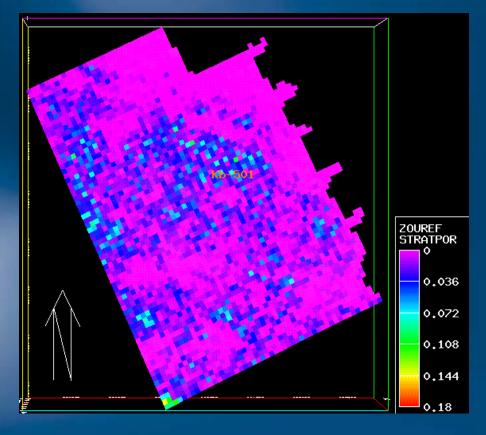


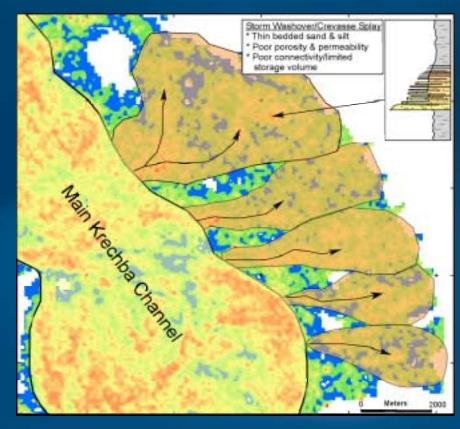
Alternative Models







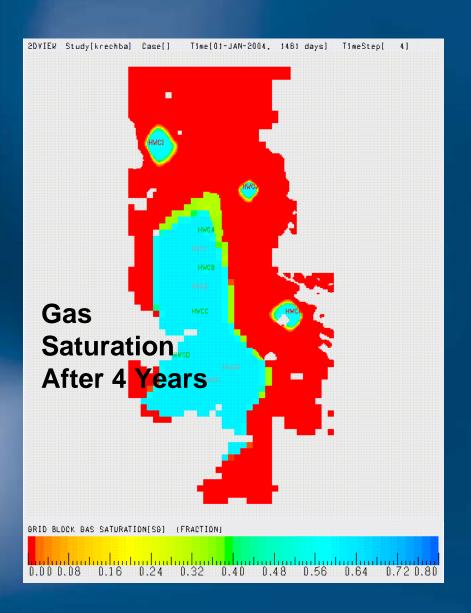


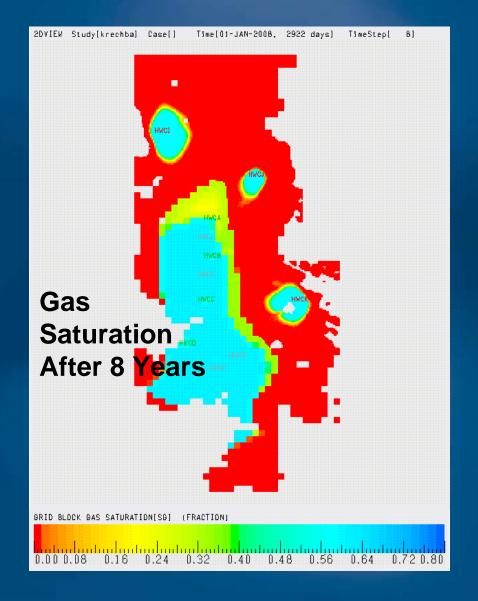


Simulated Impact of CO₂ Injection







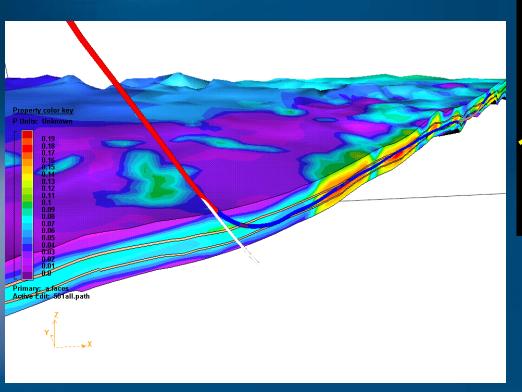


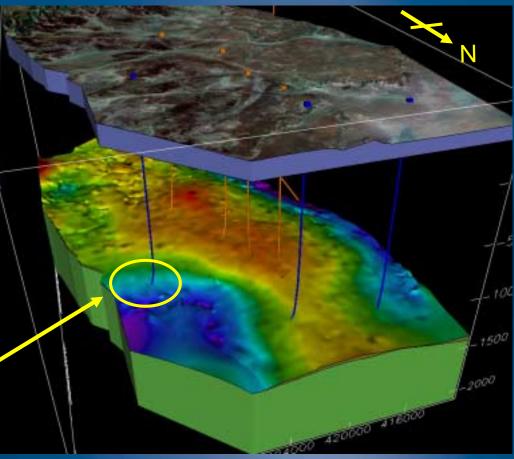
Drilling of the First CO₂ Injection





1250 metres of horizontal section in Krechba 501 completed in January 2003





2004 Project Start-Up

Conclusions





- The commitment of the BP/Sonatrach Shareholders was instrumental in achieving a shift into a new domain for environmental management.
- Management of total project emissions required identification of the source and their magnitude early in the design stage.
- Cost effective solutions and options for the future can then be integrated into the final design in an ordered and well understood manner.
- Re-injection of the Produced stream CO₂ has netted an emissions saving of ~0.9 million tonnes per annum (~\$2.6/tonne)
- Clear HSE aspirations have resulted in the ISG project capturing savings in excess of 1.2 million tonnes per annum of equivalent green house gas emissions (>60% of total project emissions)

Co-Authors: Abdelaziz Tourqui, Fred Riddiford, Brian Taylor & Mark Smith







